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CRYSTAL LAKE, VILAS COUNTY, WISCONSIN.
EPA REGION V

Pacific Northwest Environmental Research
Laboratory

Prepared for:

National Environmental Research Center
Wisconsin Department of Natural Resources
Wisconsin National Guard

July 1975

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT
ON
CRYSTAL LAKE
VILAS COUNTY
WISCONSIN
EPA REGION V
WORKING PAPER No. 66

WITH THE COOPERATION OF THE
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
AND THE
WISCONSIN NATIONAL GUARD
JULY, 1975

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nation-wide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. This report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conducting the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

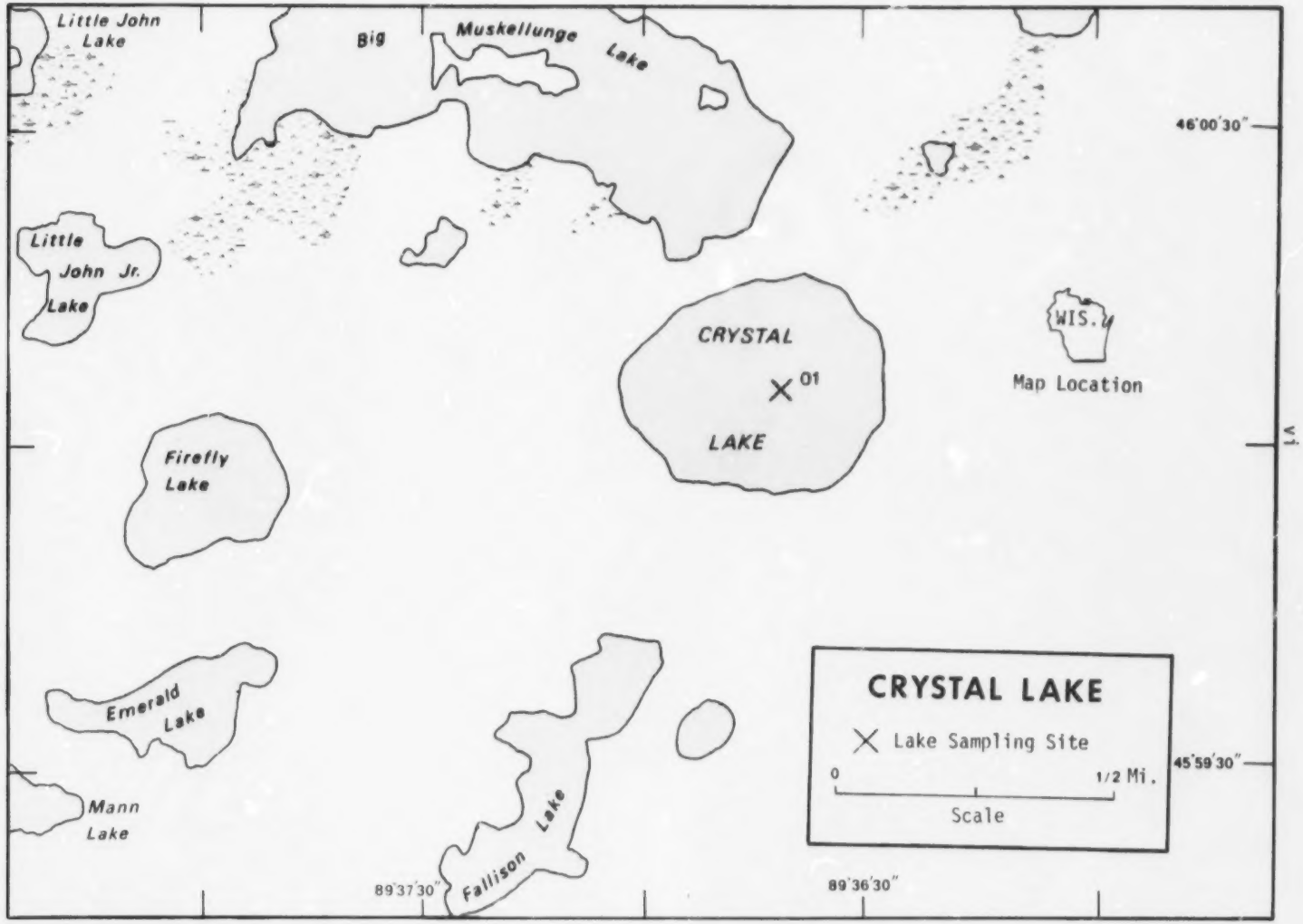
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano
Sinnissippi	Dodge

LAKE NAME	COUNTY
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


Little John Lake
Big Muskellunge Lake
Little John Jr. Lake
CRYSTAL LAKE
01
WIS.
Map Location
Firefly Lake
Emerald Lake
Mann Lake
Fallison Lake
46°00'30"
45°59'30"
89°37'30"
89°36'30"
CRYSTAL LAKE
Lake Sampling Site
0
1/2 Mi.
Scale

CRYSTAL LAKE

STORET NO. 5571

I. INTRODUCTION

Crystal Lake was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. No wastewater treatment plants impact the lake, and there are no well-defined tributaries. Therefore, this report only relates to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data and reports of others (Black, et al., 1963; Lueschow, et al., 1970) indicate Crystal Lake is oligotrophic. Of the 46 Wisconsin lakes sampled, none had less mean total phosphorus, dissolved phosphorus, inorganic nitrogen, and chlorophyll a; and none of the lakes had greater mean Secchi disc transparency. Though Survey phosphorus concentrations were lower than the range of values found by the Wisconsin Department of Natural Resources (Schraufnagel, 1973; Lueschow, et al., 1970), Crystal Lake "...has a history of scientific study as an example of extreme infertility" (Black, et al., 1963).

B. Rate-Limiting Nutrient:

A loss of 72% of the inorganic nitrogen occurred in the algal assay sample between the time of collection and the beginning of the assay, and the results are not representative of conditions in the lake at the time the sample was taken (11/04/72).

The lake data indicate phosphorus limitation at all sampling times; the N/P ratios were 14/1 or greater and phosphorus limitation would be expected.

III. LAKE CHARACTERISTICS

A. Morphometry*:

1. Surface area: 90 acres.
2. Mean depth: 27.0 feet.
3. Maximum depth: 69 feet.
4. Volume: 2,432 acre-feet.

B. Precipitation**:

1. Year of sampling: 43.3 inches.
2. Mean annual: 31.3 inches.

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* Ball, 1973.
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Crystal Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at a single station on the lake (see map, page vi). During each visit, a single depth-integrated (15 feet to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll a analysis. During the last visit, a single five-gallon depth-integrated sample was taken for algal assays. The maximum depth sampled was 70 feet.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

FALL VALUES

(11/04/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	6.4	6.4	6.4	6.4
Dissolved oxygen (mg/l)	10.6	10.7	10.7	11.0
Conductivity (μmhos)	<50	<50	<50	<50
pH (units)	6.2	6.4	6.4	6.6
Alkalinity (mg/l)	<10	<10	<10	<10
Total P (mg/l)	0.006	0.007	0.007	0.008
Dissolved P (mg/l)	0.004	0.005	0.005	0.006
NO_2 + NO_3 (mg/l)	0.020	0.021	0.020	0.030
Ammonia (mg/l)	0.040	0.047	0.050	0.060

ALL VALUES

Secchi disc (inches)	264	316	324	360

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/25/72	1. Schroederia	392
	2. Dinobryon	54
	3. Navicula	39
	4. Flagellates	27
	5. Cryptomonas	27
	Other genera	112
	Total	651
08/23/72	1. Kirchneriella	1,294
	2. Chroococcus	398
	3. Flagellates	239
	4. Raphidiopsis	202
	5. Merismopedia	181
	Other genera	267
	Total	2,581
11/04/72	1. Dinobryon	297
	2. Microcystis	169
	3. Schroederia	46
	4. Cryptomonas	22
	Other genera	100
	Total	634

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/25/72	01	0.7
08/23/72	01	1.2
11/04/72	01	2.6

V. LITERATURE REVIEWED

Ball, Joseph R., 1973. Personal communication (lake morphometry). WI Dept. Nat. Resources, Madison.

Black, John J., Lloyd M. Andrews, and C. W. Threinen, 1963. Surface water resources of Vilas County. WI Cons. Dept., Madison.

Lueschow, Lloyd A., James M. Helm, Donald P. Winter, and Gary W. Karl; 1970. Trophic nature of selected Wisconsin lakes. Trans. Wisc. Acad. Sci., Arts & Ltrs., vol. 58, pp. 237-264.

Schraufnagel, Francis H., 1973. Personal communication (review of preliminary report on Crystal Lake). WI Dept. Nat. Resources, Madison.

VI. Appendix

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

557101
46 00 00.0 089 36 30.0
CRYSTAL LAKE
55 WISCONSIN

11EPALES 2111202
5 0075 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/25	14 20	0000	17.0	9.2	360	50K	6.90	10K	0.040	0.040	0.005	0.005
	14 20	0015	17.0	6.1		50K	7.30	10K	0.030	0.040	0.005	0.004
	14 20	0025	17.0	6.2		50K	7.50	10K	0.030	0.050	0.006	0.008
	14 20	0070	7.8	11.0				10K	0.050	0.060	0.013	0.008
72/08/23	11 35	0000			324	50K	6.30	10K	0.040	0.050	0.007	0.007
	11 35	0004	20.9	8.6		50K	6.20	10K	0.030	0.040	0.008	0.004
	11 35	0015	20.8	9.1		50K	6.40	10K	0.030	0.060	0.007	0.007
	11 35	0022	20.3	10.1		50K	6.30	10K	0.030	0.060	0.006	0.004
	11 35	0032	16.4	12.5		50K	6.40	10K	0.020	0.050	0.006	0.005
	11 35	0042	11.8	12.8		50K	6.80	10K	0.020	0.050	0.007	0.004
	11 35	0052	9.8	9.1		50K	5.70	10K	0.020	0.070	0.008	0.005
	11 35	0062	9.4	7.3		50K	5.55	10K	0.030	0.120	0.012	0.004
72/11/04	12 45	0000			264	50K	6.50	10K	0.020	0.050	0.007	0.005
	12 45	0004	6.4	11.0		50K	6.20	10K	0.020	0.040	0.006	0.004
	12 45	0015	6.4	10.8		50K	6.40	10K	0.020	0.040	0.007	0.005
	12 45	0022	6.4	10.8		50K	6.50	10K	0.020	0.050	0.008	0.005
	12 45	0029	6.4	10.7		50K	6.40	10K	0.020	0.050	0.008	0.005
	12 45	0039	6.4	10.7		50K	6.60	10K	0.020	0.040	0.007	0.006
	12 45	0049	6.4	10.6		50K	6.60	10K	0.020	0.050	0.007	0.006
	12 45	0059	6.4	10.6		50K	6.20	10K	0.030	0.060	0.007	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/25	14 20	0000	0.7J
72/08/23	11 35	0000	1.2J
72/11/04	12 45	0000	2.6J

K VALUE KNOWN TO BE LESS THAN INDICATED

J VALUE KNOWN TO BE IN ERROR